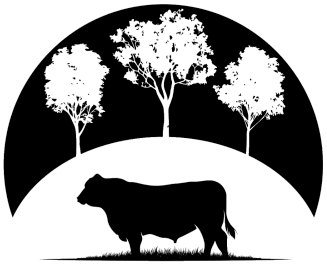

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Introduction

Silvopasture, particularly the establishment of trees in open pastures, offers significant upside in terms of production, profitability, and sustainability in the face of a changing climate. Yet because of the significant time, money and effort required to establish silvopasture, adoption is very slow. The delayed ROI is especially challenging for many farmers, as they must wait (in most cases) 5+ years before seeing any fruit from their investment.

Thankfully, this is a space where thoughtful investments can play a major role and remove this challenging barrier, while earning a significant return. This return comes through starting with an undervalued asset (marginal farmland) and making significant, long-term improvements to that asset through high-yielding crop trees, such that the livestock operation on the land can raise more livestock with lower input costs, and in many cases sell at an increased, premium price.

When discussing silvopasture in this document, my main focus will be on planted silvopasture (as opposed to thinning trees) and systems that are designed primarily to support and feed livestock, rather than producing human food or timber. Given that the bulk of land in the United States is currently devoted to production of livestock feed, rather than human food, I believe this is the single most scalable agroforestry practice by a very wide margin.

And while the work of Trees For Graziers to-date has been on a small scale as we have developed and refined methods of tree establishment and laid the groundwork for a silvopasture-specific nursery, the focus of this piece is to examine the case for large-scale,

systemic investment in our grazing lands for many tens of thousands of farms throughout the country.

Advantages of silvopasture investment:

- Excels on marginal land (grazing land, hayland, etc.) where traditional row crops do not, and where competition for land ownership is minimal compared to crop or orchard land. In essence, marginal land is an undervalued asset that can be significantly improved through the investment of productive trees.
- Once established, maintenance costs are low.
- The market for meat and other animal products is large and stable, as opposed to fledgling and small markets for human foods such as chestnuts or hazelnuts. Hence silvopasture systems designed to feed livestock can readily be applied and invested in at scale. For reference, the Spanish dehesa and Portuguese montado, the world's most famous silvopastoral system, covers 3 million hectares, or 7.4 million acres (others have estimated that the systems cover 5 million hectares).
- Because feed crops like honey locust, persimmon, mulberry and tree fodders generally do well in organic systems, their feed can substitute organic feed at organic prices, thus making their production more valuable than conventional feeds.
- Tree crops offer potential for premium market differentiation, such as by producing mulberry-finished chicken, acorn-finished ham (like the famous Iberian ham) or 'shade-grown dairy', not to mention certifications regarding carbon footprint or other sustainability and animal welfare measures.
- Because of the significant time, capital and knowledge barrier to entry, competition will lag, allowing early entrants to enjoy a price premium for longer times than for a practice that is more quickly adopted.

Disadvantages of silvopasture investment:

- Time to ROI. This will almost certainly be the #1 challenge. If you could snap your fingers and get a mature silvopasture system, they would be widespread indeed. Given that it is not that quick, and annual crops return a quicker ROI and easier cashflow, silvopasture has been under-adopted for a long time. The flip side is that this benefits those who can 'crack the nut' through a combination of finance, cost-share and management techniques to reduce time to ROI.
- Silvopasture systems generally increase management intensity, requiring more labor and specific knowledge. How much additional labor is required will depend on the type of system established. These systems will need to be managed by silvopasture-minded farmers or farming teams and, in most cases, will not be able to be leased to neighboring farmers like standard cropland would. That will also affect the pool of buyers for potential resale. Tree crops are a long-term commitment.

- The per-acre income of livestock products is likely to be lower than the per-acre income from human foods like chestnuts or hazelnuts, though certainly more scalable, stable, and resilient to price fluctuations in food markets.

Investment Strategy

The highest margin investment case for silvopasture seems to be leasing or purchasing marginal farmland and improving the land through trees that will feed monogastrics (poultry and pigs) whose regular grain feed is the primary input cost, thus offering significant savings and product differentiation, while also grazing ruminants (cattle, sheep or goats) through holistic management practices.

Meanwhile, the most scalable investment route is leasing or purchasing similar marginal land, and investing in it with trees that serve ruminants, since those are straightforward to manage on grass, and are already managed on millions upon millions of acres of pasture, whereas large scale pasturing systems no longer exist in the US for hogs and poultry. While anyone can grow good grass and raise comfortable cattle in the spring and fall, silvopasture can give an operator significant advantages in the summer and winter. In the summer, shade for livestock, less-stressed forages, and access to tree fodder all add up to greater resiliency, better weight gain, stronger forage production, and hence greater profitability. In the winter, the ability to protect from wind increases feed efficiency, and honey locust, persimmon and other tree crops can be used to provide high-energy feeds going into winter. Operations with well-stockpiled forages, fruit, and pods on the ground, and windbreaks all around stand to have lower costs of production as well as higher output per acre.

Draft Playbook

- Secure long-term stable access to marginal farmland, such as degraded cropland, hay or grazing land. In general land will be too sloped, dry, wet, rocky, sandy or clayey to crop profitably.
    - We do not want to compete with row crops on good quality row crop land, unless the price is low enough.
    - As suggested by Paul McMahon in The Investment Case for Ecological Farming, farmland should be in areas where the price is not driven up by non-farming factors such as development, unless of course you're able to lease land.
    - Leasing is usually much easier to cashflow than purchasing land, and much more profitable as a means of running a farming business. With tree crops the added challenge is of course the long-term nature of the returns, hence any lease would need to be structured in such a way that land access is secure for the one investing in silvopasture systems.

- Establish the right trees on the property. This of course requires that the land is in an area that can support trees, whether through natural rainfall, irrigation and/or management techniques to conserve and better use available water.
- To reduce the costs (money + time) of the investment, look for the following opportunities, among others:
    - Find cost-share for tree establishment, through NRCS, carbon credits or otherwise.
    - Maintain cashflow through integrating crops and/or livestock right away, if practical. Alternatively, use the grasses present, or other biomass, to mulch trees and increase growth, thus reducing time to ROI. Irrigation is also useful if available, though options may be limited on marginal land.
    - Find patient capital willing to invest in long-term returns at reasonable terms. Ideally, invest with a fund large enough that it does not need to cashflow the land purchase through farm revenue. The farm can be purchased and held as an asset that will naturally appreciate, with revenue from farming yielding dividends.
- Empower the right management of the land.
    - Land can likely be leased out in the early years, before trees are established and yielding, to nearby farmers, and simply making hay seems the easiest fit in most cases, as it won't disturb the trees as they grow.
    - To fully manage this land to its full potential, you'll need the right farming team on the ground. And because this tree crop /livestock combination is so unique, it's not just any farmer that will know how to manage it. This will require a crew dedicated to understanding the system and optimizing it over time. This sets investment in silvopasture apart from investment in row crop land, which can readily be leased out to any number of nearby farmers. Silvopasture requires thoughtful management of livestock, forages and trees, thus requiring a different skillset than that commonly held.

The main returns on investment should come in several forms:

- Baseline appreciation of land over time (if the land was acquired)
- Baseline rental value of land
- Improved management of land through improved grazing practices
- Increased livestock production on account of tree crops for livestock feed
- Other returns or reduced costs to be discussed later (through shade, shelter, carbon sequestration, etc)
- Potential product premiums
- Above-baseline appreciation of land due to having invested in the asset through silvopasture, thus allowing the future owner to earn a higher return if the land is sold

Rough Calculations for Tree Crops Revenue

Here comes the interesting, but also challenging part: calculating ROI. Unfortunately, we just have very, very little data available on the production of most of these tree crop feeds we'll discuss, or how they can best be used by livestock. The best resource I am aware of is the book

Tree Crops by J. Russell Smith originally published in 1929. Not exactly a very recent source, nor was much of it scientifically trialed, but it is filled with once-common practices that were widespread before the industrialization and chemicalization of agriculture. Just as organic farming was just the way farming was done before the Green Revolution, silvopasture was just how it was done for many farmers before WWII. And just as organic best-practices have needed to be relearned and adapted for 21st century agriculture, so too we'll need to relearn and adapt silvopasture for our current context. Given the challenges of delayed ROI associated with establishing silvopasture systems, it only makes sense that re-adoption of silvopasture would lag behind other practices that have gained traction in recent decades, like organic farming and grass-based livestock production.

Below are some ballpark estimates, based on numbers shared in *Tree Crops*. I will try to balance conservative estimates with upsides that might be achieved through techniques like clonal propagation of improved trees, irrigation, etc.

Note that I'll break down notes by tree type, but any tree planting would be made up of a diversity of trees, all complimenting each other. Mulberries would drop their fruit early in the season, followed by apples, persimmons, oaks, chestnuts, honey locusts and more that are not discussed in detail, like hazelnuts, pears, hickories and more. Our aim is a perennial polyculture of the very best, high-yielding trees available, one that is composed to balance high output with resilience.

There's a lot of room for variables when it comes to setting a fair-market price for our tree crops for livestock consumption, since it depends fully on how much feed cost you're expecting to offset. In general, our tree crops are going to be similar to ground corn in feed value, at least close enough to use as a good proxy. Ground corn makes up a large portion of what farmers feed to livestock. I suggest using that as the proxy value, rather than corn by the bushel at harvest, which is not what growers are feeding their livestock.

When setting a price for what is reasonable, your range might be anywhere from about $.20 to about $.40/pound. The higher range is going to apply to organic corn, and given that tree crops generally do well under organic, low-input systems, one is in a good position to use those tree crops to offset premium organic feeds on the higher end of the price range (not to mention the premium offered for grain-free or corn-free or similar niche feeds). However, there is reason to use the lower end of the price range, if you intend to sell into the larger commodity market that doesn't have the premium price differentiation. While an organic premium is certainly desirable, it may not be practical in your context. In that case, using a lower figure such as $.20/pound to offset conventional grain is a more conservative approach. Recognizing that each situation will be different, I will use the $.40/pound as the standard in this document, to give some sense of monetary returns for each tree crop we discuss. Please adjust according to your context.

Mulberry

- Mulberry is likely the #1 tree feed crop for monogastrics, given that it is highly enjoyed by poultry and hogs, and drops in the early summer when few other perennial crops are dropping fruits or nuts. It is low-maintenance, grows fast, yields quickly, is very high in protein for a fruit, and can be produced inexpensively and grown on poor, abused, marginal soil.
- I write extensively about mulberry in the article Pigging Out on Mulberries, again leaning on *Tree Crops*. Since there's nothing like an actual feed trial at a university, I've tried different ways to estimate the monetary value of the reduced feed costs under mulberries. Even if the assumptions given are high, I'd say reducing feed costs by $1,000-2,000/acre is very reasonable.
- For the sake of one simple and conservative estimate, let's estimate that one mature mulberry tree can offset 3 pounds of feed per day for 50 days. Many examples in *Tree Crops* stretch that timeframe over 90 days. At $0.40/pound of feed, that's a value of $60/tree, and an acre could hold 35 trees.
- The fact that mulberry yields at an early age, and is cheap to establish, is very important. It can be planted heavily in early years and start producing ROI well before the slower-growing oaks and persimmons start to mature.
- Statements such as these in *Tree Crops* are telling: *"All through the Southern states, mulberries are commonly used as feed for pigs and poultry. In North and South Carolina and Georgia nearly every pig lot is planted with these trees, and the mulberries form a very important addition to the pig's diet."* The fact that this was the norm before the industrialization of our food systems says that these trees were indeed a worthwhile investment, and widely considered so by farmers with direct experience. That should be even more so today, given current access to cost-share for silvopasture, cost-share that likely was not available to the folks throughout the South planting trees on their farms in the early 1900's. Also, products grown today via these traditional methods will yield a significant price premium, which was likely not the case 100 years ago. When folks ask me whether it makes sense to plant trees for livestock feed, my best evidence is that people have been doing it for a long time, even with much fewer resources and incentives available than we have today.

Persimmon

- Persimmon fills a valuable niche among tree crops, providing high-energy feed that can drop from August through February, and is relished by all manner of livestock and wildlife. They pick up where mulberries leave off in the season.
- A useful estimate (page 127 in *Tree Crops*) from a horticulturalist in Kansas (the far western part of the persimmon's range) says they consider 4-5 bushels of persimmons to be a good yield. Planted at 30x30' spacing yields 48 trees and 240 bushels/acre at the 5 bushel mark. Because persimmons have more water weight in them than corn, you need to compare the two on a dry-matter basis, which brings the number for persimmon down to about 100 bushels of corn equivalent per acre. Not at all shabby given the very

minimal inputs required. 100 bushels x 56 pounds x $0.40 yields a per-acre return of $2,240 annually.
- Very similar yield numbers can be found from an industry report noting annual averages of 6.95 tons, or 248 bushels of fruit. Again, a practical corn equivalent is likely around 100 bushels per acre.

Honey Locust

- Honey locust is the tree we believe has the most upside in ruminant-based systems, due to its ability to drop high-energy pods in the early winter at exactly the time that cattle need more calories in their diets. Because ruminant systems are the most widely applicable, by far, honey locust is also the most widely applicable tree crop.
- Honey locust also casts a dappled shade, which allows abundant light to the pasture below. Hence it is perfect for two-story cropping with pasture beneath.
- The ideal scenario for investing in honey locust is in organic grass-fed systems, where honey locust pods provide a grain-free energy supplement for the ruminant livestock going into winter, whether that's to put the final pounds on before a butcher date, or so the herd can get by on less purchased feed (hay) during the winter months.
- In this article I use very conservative numbers for yields and tree stocking, but using higher numbers of 36 trees/acre (still very reasonable) and sugar production of 29 pounds per tree gives us 1,044 pounds of sugar per acre, or the replacement for $835.20 worth of organic molasses. And this doesn't regard the value of the other 65% of the pod that is not sugar.
- An alternative calculation, based on numbers from Auburn University in the 1940's, gives an average of 43kg, or 95 pounds of pods (dry weight) per grafted Millwood tree over the course of 4 years, while the trees were only 7-10 years old. At a density of 36 trees per acre, that's 3,420 pounds annually. At an estimated value of $.40/pound compared to organic corn, that yields per-acre returns of $1,368/year.

Oaks

- One tree (page 157 in *Tree Crops*) averaged 20 bushels/year. It was 51' wide. Let's estimate final spacing at 80x80, or 6.8 trees/acre, which results in 136 bushels of acorns/acre/year. In the Montado region, where the above yield number was found, oaks are spread far apart because the relatively low rainfall cannot support a full, closed canopy forest. Higher stocking rates could likely be achieved in areas with greater rainfall, although you would still need to strike a balance of shade and forage production.
- In comparison, the US average for conventional corn is 172 bushels/acre, and organic would be less, maybe 150 bushels.
- Now, that's from what Smith calls a 'genius tree', a standout specimen, and an old one at that. But we can clone that tree. And the tree was in Algarve Portugal, not exactly the most fertile or well-watered region, receiving roughly 20 inches of rain annually.

- Page 159 gives an estimate of 100 bushels of acorns annually on sandy, low-fertility Minnesota land that could then only yield 30 bushels of corn.
- Several times throughout the chapter various voices propose that oaks can yield more feed per acre on poor ground than corn could, especially if trees are managed, which usually they were not.
- Let's use 60 bushels/acre to be on the conservative side of things, assuming improved genetics and careful management of trees. At 40% moisture, we need to adjust down to about 15% moisture to get about 2,370 pounds of corn equivalent. At $.40/pound compared to corn, that's $948/acre/year.
- The nut crop yield does not take into account the premium for acorn-finished pork, or the timber value of oak that's slowly built over time. The challenge with oaks is that they tend to grow quite slowly and mature much later in life.

Chestnut

- Chestnut has the advantage of having more recent study and a strong interest in growing human food crops. Hence, I'll have more recent numbers and need not rely on J. Russell Smith for information.
- I should note that we will still focus here on trees for livestock consumption, not human consumption, for the reason that livestock feed represents a vastly larger investment opportunity. While currently the market for chestnut food is very attractive, I believe it will eventually see a very significant price decrease as more supply comes online in years ahead. Thus, a useful strategy may be to develop a chestnut system with the potential for human consumption, with the reliable fallback of use by livestock should the market for nuts prove unprofitable.
- Red Fern Farm says that a well-managed chestnut orchard should yield 3,500-4,000 pounds per acre per year. Their numbers should be trustworthy given their significant experience with the tree, and overall they seem to be even-handed in their educational materials. Let's assume less management for a silvopasture system, and estimate yields at 2,500 pounds per acre per year.
- Now, chestnuts are roughly 50% moisture when fresh, so that 2,500 lb number needs to come down to more like 1,250 dry weight, similar to 1,470 pounds of bought feed. At $0.40/pound, that's $588/acre/year of revenue.
- Likely the most scalable application for chestnuts is to grow timber-form chestnuts with American chestnut genetics for a combination of shade, timber and nuts, with the nuts being a smaller portion of the overall returns sought. Chestnut timber is very high quality, very strong, and rot resistant, and the American chestnut tree has strong cultural support from the general public.

Mesquite

- Mesquite is potentially very interesting, as it grows on very marginal land in arid regions, where extensive grazing is the norm. Land prices are low, and ranches are large. If mesquite could considerably improve the returns of a piece of land, and that land could be acquired at low cost, the upside potential is tremendous.
- Mesquite is a large family of trees, and one that breeders would need to do significant research on to identify the most promising strains, breeding needs, etc. But because it can thrive in very marginal regions, with minimal care, and significantly improve the output of the land, it's an intriguing prospect for silvopasture. Selection should happen for trees that are thornless, with consistently high yields of pods with a balance of sugar and digestible protein.
- Algaroba or kiawe is a type of mesquite, and yields very heavily. It is common on the islands of Hawai'i.
    - "Wherever the belts of algaroba timber are large, it has been found possible to maintain stock for a month or two of each season without any other forage than algaroba beans." -*Tree Crops*
    - Yield is estimated at 4 tons/acre (pg 54). Equates to about 145 bushels of corn, though they should likely be docked some value because their seeds (and hence the protein therein) primarily passed through the digestive tract intact.
    - Pods collected from a 60' wide tree weighed 500 pounds. The tree yields twice annually, for 1,000lbs/year. You might only want 8 trees per acre at that size, again giving roughly 8,000 pounds/acre. Even if you dock the value of the pod for lower protein, maybe to $0.30/pound, you still get $2,400/acre/year.
    - Note that the above examples are from Hawaii, where though it was dry, the trees also had favorable temperature year-round, which will not be the case for much of the territory where mesquite thrive.

Livestock Types

Silvopasture systems bring the best of pastures together with the best of trees, hence offering a very high-quality habitat for just about any livestock type. There are ample reasons for anyone producing livestock on pasture to invest in silvopasture.
But when it comes to investing in land for the specific purpose of establishing profitable silvopasture systems, we'll want to be strategic about which livestock types are best suited to silvopasture, and which offer a relative competitive advantage. For example, a silvopasture provides more of a competitive advantage for growing hogs than for growing cattle, because cattle will still get the bulk of their feed from pasture regardless of the trees, whereas trees can offset a large portion of the feed needs for hogs, thus reducing input costs and offering a premium product. However, cattle will be much easier to design silvopasture systems around at real scale, while hog systems, and certainly poultry systems will need a lot of development.

Chickens and other poultry

- Chickens are a great fit with silvopasture. As descendants of jungle fowl, they do best when they have access to shade and cover, and thrive on feeds like fruits and nuts. Turkeys are inherently woodland animals as well, while ducks and geese thrive on the lush forages in shaded pastures. Poultry in general are small, making it easy to protect trees with birds present.
- The big advantage of feeding meat birds on tree crops, whether that's broilers, ducks, geese or turkeys, is that they finish over a short period of time, and you can concentrate your growing seasons when fruits are dropping. This is a big advantage over layers, which need consistent feed all year round, so the tree crops could only make up a significant portion of the feed during the appropriate season. One workaround would be to raise replacement layers, as those are then ready to lay in about 4-5 months, a perfect time window to maximize use of tree crops.
- Another upside of raising poultry is that turkeys and geese are already associated with seasonal production for special occasions and can often fetch a premium price in a seasonal production model.
- A major downside of poultry is the need to protect them from predators. Most broilers on pasture are raised inside of portable 'chicken tractors' for a reason, namely for the high level of protection they offer. Those systems wouldn't work if your goal is for the poultry to access fruit within the silvopasture. For that, they need to have free access outside, and protection methods will need to be customized around that.
- One will want to select poultry with the most capacity to range, so they can effectively move to their feed. This is especially important for broilers, as most commonly raised meat chickens can only take a handful of steps at a time. You will want to choose breeds developed for their ranging ability, like Freedom Rangers or dual-purpose breeds where the males can be raised for meat.
- Overall, the potential upsides of feed cost reduction, improved animal welfare, and premium product make poultry silvopasture systems very interesting, but there are real challenges that will need to be addressed to create systems that scale well.

Pigs

- Pigs have a major advantage over poultry in that they can eat a much broader diet. While the list of practical trees for feeding chickens comes down mostly to mulberries and persimmon, hogs can make great use of those plus acorns, chestnuts, hickories, apples, pears, hazelnuts, and more. That permits a much more diverse and multi-functional planting.
- Pigs can also range much further than poultry, and don't need nearly the same level of protection, making them much lower maintenance. Traditional means of raising pigs on mast crops had farmers turning the pigs out for weeks or months at a time to freely roam a large area. Do that with poultry and the foxes will thank you.

- There is a very simple case to be made for having acorn or fruit-finished pork as a premium product. Iberian ham or pannage pork are already established premium products, with production falling far short of demand. A seasonal, regenerative and very differentiated product would fetch strong prices.
- Pigs are large animals, and can cause more damage than poultry. Rooting and rubbing are two things to watch out for. Neither needs to be a problem, assuming thoughtful and proper management. One would need to wait longer to incorporate hogs into a silvopasture system than for poultry.

Ruminants

- In general, there doesn't seem to be much margin on the production of ruminant livestock. Beef cattle are very commonly raised at a loss, largely by folks who have a town job, inherited the land or bought it as a hobby farm, and just want some animals to keep the back 40 down. Profitability is not required for them, and it's hard to compete as a business when others are willing to produce at a loss.
- Sheep and goats require more care to raise, and hence are less common. The US also has less of a culture of raising and consuming sheep and goats. However, ethnic markets have a solid demand, and the profitability on these livestock is likely more promising than for cattle. That said, I estimate that the rise in using sheep in large agrivoltaic systems (which coincidentally looks like a techno-modernist silvopasture) will raise the supply of sheep, and likely reduce the price one can fetch over time.
- Despite the above, silvopasture offers unique advantages to those in the ruminant livestock game. Doing the same thing as everyone else is always a recipe for middling results, regardless of industry, and in agriculture, middling is to lose money. In the grazing industry, silvopasture allows land managers to take advantage of key seasonal niches that allow them to thrive while others are struggling under conventional management and higher input costs. A well-designed silvopasture system for ruminants allows landowners to play the largest pasture-based livestock game currently available, and create the conditions to consistently buy low and sell high.
- Having consistent and well-spaced access to shade can significantly increase weight gain rates during warm months, while supporting the growth of cool-season forages, which are readily stressed by hot summer temperatures. Growing trees specifically for leaf fodder could be a really interesting approach as well, offering drought-resistant feed during a critical time of the year. Fodder systems are particularly interesting for feeding goats and sheep, given how much browse they like to incorporate into their diets. High-tannin tree fodder can also offset the negative effects of fescue, thus making millions of acres of currently low-productivity grazing land across the 'Fescue Belt' significantly more productive.
- Silvopasture also offers a key upside for winter grazing, as windbreaks reduce cold stress and improve feed efficiency, and additional high-energy feed is dropped from trees to put good condition on livestock before winter. Mast-producing trees like honey locust or persimmon spend the entire growing season collecting solar energy, and

turning that into feed energy (carbohydrates), which can then be consumed by livestock at a critical time of year.

- Worth mentioning is that bamboos, including the native river cane, offer a unique combination of drought-resistant summer fodder, green winter fodder, excellent windbreak and shade. The key challenge seems to be establishing it cost-effectively at scale, but the upside of having this versatile plant to provide seasonal resilience on grazing systems is very much worth pursuing.
- Optimizing a grazing ecosystem for summer and winter performance through silvopasture could be particularly interesting for those doing custom-grazing, or other short-term stocking agreements, where they can take advantage of seasonal abundance when all their neighbors are dealing with heat stress, cold stress or overgrazed pastures.
- Given the widespread use of ruminants, especially cattle, on pasture, it seems that this is the most likely starting point, and most widely scalable silvopasture practice. Integrating monogastrics is going to take more work to do well, with the main concern with pastured pigs being the damage they can cause when poorly managed, and the main concern for poultry being the damage that can be done to them without high levels of protection. Though margins might be slimmer with ruminants, the ease of scaling silvopasture to support them likely more than makes up for that.

Complimentary Opportunities

Now that we've examined the main mast-producing species, as well as how one might integrate various livestock with them, let's turn our attention to other benefits and opportunities trees can bring our way. Some, like shade, will be natural and automatic outcomes of planting trees, while something like agrotourism would take a concerted effort to add to an operation, but offer significant chances to diversify the farm business.

Shade

- Shade is the lowest-hanging fruit of silvopasture, and the place where most farmers start. Adding shade to pastures is a simple, straightforward means of reducing heat stress on any operation, and the warmer the region, the more benefit can be obtained through shade.
- As I write in "What's It Worth? Shade For Your Pasture", a rough rule of thumb to use for estimating increases in weight gain with shade is $1.25 per day of heat stress. Depending on your context, you may see 150 of those days, or maybe just 50. A farm in our area of Pennsylvania might expect to see weight gain benefits from shade throughout much of May through September, and maybe 100 days in that timeframe.
- If you have one stocker for every acre, having that shade in this case would add about $125/acre/year.

Windbreak

- Getting livestock out of the cold wind makes a real difference to livestock performance and the farm's bottom line. It helps livestock maintain their body condition, reduces how much feed they need to burn through in order to stay warm, and is particularly important for keeping young from suffering or even dying, especially in the case of newborn lambs, or in cold, wet and windy conditions.
- Feed savings can be very significant. A farmer shared with me that his hay consumption went down by ⅓ from one winter to the next through the use of a barn, which is just a very effective windbreak.
- The article "Investing in a Windbreak Could Reduce Feed Costs" proposes a 27% increase in feed energy required for cattle in their theoretical scenario. While the author was able to use inexpensive distillers grain to make up for the energy shortfall, farms raising grass fed beef don't have that option, especially since feed energy is already in short supply. That's one place where honey locust pods, persimmons, apples and more can show their value. In the absence of those mast crops, the grass-based alternative is hay. If a cow day is $2.50, and gets increased by 25%, that's an additional $0.63/day. Over 100 days of winter, that would be $63 per head.
- Now, a windbreak isn't likely to completely eliminate increased feed requirements over the winter. Without better numbers to draw from, I can't give a worthy estimate of savings, but any silvopasture system in regions with cold (and wet) winters would do well to include windbreaks in key areas.

Summer Fodder

- The upside of tree fodder is that tree leaves can remain green and nutritious long after forages have gone brown from drought. This provides a natural drought insurance, and tree fodder can reduce dependency on overpriced hay. The larger and more wide-spread the drought, the more people become short of feed, and the higher the cost of hay, or any other replacement feed. In essence, tree fodder is a hedge against drought, and provides a secure form of feed at a time of year when one would otherwise be subject to shortages and/or overpaying for supplemental feed.
- There's not been enough published on the feed value of tree fodder to give a solid estimate of what monetary value one could be looking at. It also varies highly on context (as all these returns do), species used, management, etc. The video entitled "Pollarding Willows from Within the Tree (around 4:05) from New Zealand, where there's a rich history of using trees for fodder, shares that trees cut every 5 years can provide about 10 cow days worth of feed every harvest. This estimate is likely on the higher end, but the bright green trees against the brown background clearly show the value of tree fodder during the summer.
- The cost of a cow-day of hay varies, but some numbers by the University of Missouri show $2.50 to be a good ballpark estimate to use. If each tree can yield 2 cow days per year at $2.50/cow day, that's good for $5/year. Given that fodder trees are generally

cheaper than masting trees to establish, grow quicker and yield earlier, that's a great return. And, one could readily plant 100-200 per acre if they really wanted to maximize summer feed, though lower rates will be common for most farms.

- Note that some species can be fed at higher rates than others. Willows, for example, are high in tannins, and are generally not fit to replace a full diet, whereas poplars, mulberry, elm, ash, linden and others may be able to make up the bulk of a summer diet.
- If a farm aims to feed tree fodder at scale, it would be worth considering establishing coppice systems that can be managed mechanically, rather than pollarded trees needing to be managed by hand, oftentimes even from a ladder, increasing both labor intensity and risk. Here we would look to Australia for one example, as shown in the video "Tagasaste Management", where land with poor, sandy soils could support several times the livestock production when tagasaste shrubs were incorporated, and regularly cut back mechanically to keep the fodder within browse height.

Timber

- When planting and managing trees, it only makes sense to keep in mind the income potential from the trees itself, rather than only having an eye for the way the trees will serve livestock. This is a long-term investment indeed and not one that will support the farm cashflow for the first few decades. But when integrated into a holistic whole-farm strategy, timber can make a lot of sense and significantly strengthen farm ROI.
- For example, oaks planted primarily to provide acorns for livestock can be pruned in such a way that they will also yield timber when their useful life is over. In essence, the investment cost in that tree as timber is only the additional cost of pruning it into a timber shape, since the main purpose and justification of planting the tree was for livestock feed. This is the approach taken by Rowan Reid, a leading international agroforester in Australia who advocates for the strategic inclusion of trees on livestock farms in his book Heartwood.
- Take for another example a simple system where land is purchased and will primarily serve ruminants. There's a case to be made that simply buying the land as an appreciating asset is a solid and safe inv estment. But that investment can be much better yet if it is planted in black walnut and black locust, two of the best timber trees available. Black walnut because it has unmatched value, and black locust because it grows so quickly. In many cases you can get 100% cost-share for the tree planting, so your investment cost is $0. Because the trees do not hinder grazing, they do not affect cashflow. In fact, their shade will likely increase per-acre production through reduced heat stress on livestock. Carbon credits can be an additional bonus. And because you didn't have to pay for the timber planting, any revenue from timber will be a (significant) bonus. Whether investing in timber or otherwise, we'll want to seek out such strategies in order to reduce our risk and give ourselves the highest chance of a solid ROI.

Tree Crops

- Although planting trees to serve livestock is the most scalable of agroforestry practices, there is plenty of room for integration with human crops. One interesting way to do that is to establish tree crops that have a high upside if sold for human consumption, and if that does not end up being profitable, they can provide quality livestock feed. Those trees offer high upside, and low risk, given a readily available backup market.
- Examples include:
    - Chestnuts, which are already being heavily invested in by folks like Propagate Ventures, and are very well suited to marginal land, so much so that they thrive on mountainsides throughout Europe, where they form the backbone of entire traditional cultures. If the market gets glutted, nuts can always be fed to pigs, turkeys or cattle.
    - Hickory oil. There is a nascent hickory oil cottage industry, which produces a product similar to olive oil, and is our only substantial tree oil in the Eastern US. Hickories can thrive in a wide range of soils and regions throughout the Eastern US, and offer the upside of a high-value oil crop. If that does not turn out to be profitable (and the jury is still very much out on that given questions about how this can scale up, gain efficiencies, etc) the tree is still a valuable tree in pastures, providing nice shade, valuable timber and nuts that can be consumed by hogs.
- Given that the scope of this piece is on silvopasture investment practices that can be applied at the scale of tens of thousands of acres, at this point I am reluctant to recommend investments in tree crops at that scale. Meanwhile, 10 million acres of new silvopasture that is focused on reducing feed input costs and heat stress for livestock operations is just the beginning of what can be profitably done.

Agri-Tourism

- Silvopastures offer abundant habitat for a whole range of wildlife and livestock, as well as a beautiful park-like aesthetic that is inherently appealing to people. There may be no better way to engage and educate the public about the possibilities of regenerative agriculture than through interacting with a silvopasture system. It gives people the opportunity to learn about habitat niches for various animal and tree species, historic uses of the different components, like pannage pork or oak savannas, and even offers a fantastic opportunity for direct retail sales of product grown on the farm.

Hunting

- Silvopasture systems are in essence savanna ecosystems, which support more wildlife biomass than any other ecosystem type in the world. There's a reason that Native Americans used fire to manage huge areas as savanna: they produced the most game through greening up the grass and favoring masting trees like oaks and hickories. In a

silvopasture, the opportunity to manage for wildlife through hunting means a lot more diversity of trees can be added that otherwise wouldn't be taken advantage of by livestock, like apples, pears or plums that can draw in and grow large deer.

- The real kicker for this business option is that hunters are generally much less price conscious than farmers. It's common for hunters to spend thousands of dollars on a premier hunting experience, which is what a well-designed silvopasture can create like none other.
- Ohio Land & Cattle is one business that offers premium hunting opportunities on their 8,000 acre ranch, along with a very savvy livestock business model which they discuss in detail on their website.
- In many cases, farmers in the Spanish *dehesa* see more income from hunting leases than they do from livestock products, given the significant wildlife value that their silvopasture systems create.

Ecosystem Services

- The main way that ecosystem services incentives support silvopasture investments is simply when cost-share programs are offered to plant trees. Government and non-profit groups recognize the ecological benefits of trees, and paying for practices like tree planting is more straightforward than setting up complex markets to pay for actual delivered ecosystem services. In our case, this allows the investment in planted silvopasture systems to be supported through the public, given the range of ecosystem services that will then be returned to the public. NRCS is the main cost-sharing entity in US agriculture, and EQIP is likely the most applicable program.
- Carbon credits are at this point the most accessible means of directly monetizing ecosystem services from silvopasture, and according to Project Drawdown, silvopasture is the #1 practice for sequestering carbon on actively farmed land. Working Trees is one company already offering carbon funding for planted silvopasture, which in some systems (again, assuming we're working with marginal land) can be more profitable than current land usage, though that would require planting said trees at relatively high densities. So, if you can get cost-share to plant trees (assets that improve the productivity of your land) at no cost, and get carbon credits equaling the previous land use rates, and can also lease the land out for grazing at similar rates to before, you have the makings of a strong investment.
- Working Trees pays for the carbon sequestered in the aboveground biomass of trees, which is easier to measure and can be applied to smaller acreages. Large acreages open the opportunity for monetizing belowground carbon sequestration as well, given that larger farms can absorb the higher fixed costs of measuring and verifying belowground carbon.

Challenges

While silvopasture presents a lot of upside, it is a practice that is only recently being rediscovered and adapted to the 21st century. Much of the information we rely on is old and spotty, much of the techniques or memory has been lost, and very few practitioners have real world experience with the practice. In this section we'll summarize some of the main challenges associated with adopting silvopasture, particularly at the scale needed for multi-thousand acre investments.

Not enough of the right trees

- If today you wanted to buy enough improved mulberries or honey locust or persimmons to fill 1,000 acres, you'd be extremely hard pressed to do so, especially if you wanted quality stock at a reasonable enough price to make the investment profitable. There simply has not been a significant demand for these trees over the last decades, and hence there is very little nursery supply.
- It's for this reason that TFG has started a silvopasture-specific nursery, though the work required there will take time. Genetic selection, new propagation techniques to bring costs down and more will be required to raise the bar of quality while bringing costs into the range where these plantings can be profitably done at scale.

Time to ROI (and doing projects in phases)

- As mentioned in the Disadvantages of Silvopasture, a key issue we face in agroforestry in general is the long-term ROI. The quickest real ROI one could see in silvopasture is having poplars or other fast-growing trees providing shade within 2-3 years, or dwarf mulberries maturing and fruiting in that same timeframe. In the world of agroforestry, that's an amazingly fast turnaround. Other trees will take 5-10 or more years to bring significant returns in the form of fruits, pods or nuts—not to mention timber.
- A silvopasture investment will require real patience on the part of investors. That will require real steadfastness, a commitment to sticking to what's been started. This investment is certainly not for everyone, as the combination of foresight into this new opportunity, and patience to see it through is likely to be rare.

Insufficient or spotty cost-share

- One of the best ways to bring down the risk of the investment in silvopasture is to access cost-share, as a means of leveraging public investment in conservation. Because silvopasture is a powerful means of sequestering carbon, improving water quality, holding water in the soil and creating wildlife habitat, it only makes sense that public dollars would be used to support it, mainly through the NRCS system.
- Unfortunately, at the moment there is really only very spotty cost-share, which varies widely by state NRCS system. Some states, like Iowa, Indiana and Missouri, offer solid

cost-share for silvopasture. Most other states offer no cost-share, or have fairly low incentive payments. I anticipate that this will change in the years ahead, as the profile of agroforestry rises and the need to invest in climate-smart practices becomes more clear. That said, government programs do not always follow common sense, or react quickly to newly discovered best practices.

- It should be noted that even where cost-share is on the books, most NRCS staff will be unfamiliar with agroforestry practices, hence complicating the process of qualifying for cost-share.

Properties in prime silvopasture regions tend to be small

- In general, silvopasture is best suited to regions east of the 100th meridian. There are of course exceptions, like in the Pacific Northwest, or species like mesquite that tolerate dry climates, or where supplemental irrigation can be provided.
- The eastern side of the country tends to have significantly smaller farms than the western half of the United States, where it is not uncommon to find 1,000-acre ranches. Properties that size will be much more challenging to come by in the east. Compare this to the context in Brazil, where large ranches can be found in areas that not only grow trees, but grow them several times faster than we can in the eastern United States, given the tropical climate of Brazil and ample moisture.

The need for specialized management

- As previously mentioned, silvopasture is not a common practice, and requires more intensive management than grazing alone. It cannot simply be leased to any number of neighboring row croppers like cropland could be. If the right grazier or team could be found nearby, that would be one option, but in many instances it may be necessary to put a management team in place to run the farm, thus increasing complexity of the investment.

Summary

There's a real reason why silvopasture has not taken off across the US. It takes nursery stock that is currently in short supply. It takes creative management to thoughtfully integrate livestock and trees in the same space. It takes up-front investment of time and money. And most importantly, it takes patience, foresight and determination in a culture on the lookout for quick deals and easy wins. Applying silvopasture at scale requires real vision of a world that can look monumentally different than it does right now. But to someone who possesses that vision, all of these challenges are plusses. As Howard Marks wrote in *The Most Important Thing*: “You can’t do the same things others do and expect to outperform.” If others are thinking short term, the few who think long-term stand to gain tremendously. When most think there’s no money to be made in farming because so few farmers make money, therein lies another opportunity. When

cattlemen don’t understand trees, and tree people don’t want to deal with livestock, the person who can join the two is looking at a real ecological and economic niche. It pays to think different.

I believe that the time is right for silvopasture to be applied on a tremendous scale. It is a rare triple bottom line practice that directly benefits people, planet and profits alike. I also believe many will be slow to take this on which is why I hope that those few who really get it, who understand how transformative this can be, will also run with it for the good of all of us.